Space Weather Technical Forecast

Issued on Sunday, 28 May 2023 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 radio blackouts likely. Active electron fluence.
Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low in the last 24 hours with only C-class flares observed. The strongest of these was a C8.4 flare from AR3314 at 27/0435UTC. This region has evolved a delta spot in this period and presents a significant risk of further flares, despite being small and compact. AR3315 is the other high risk region on the solar disc and has just rotated into the western hemisphere. This group has seen a decline of a central delta spot but still exhibits notable magnetically complexity. Previously active AR3311 continues to fade. The remaining regions are either stable or evolving slowly.

A CME observed leaving the south of the Sun on coronagraph imagery late on 26 May has been assessed as possibly glancing the Earth, on 30 or 31 May but with low confidence.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 have declined from 525km/s to around 425km/s as the Earth exits the influence of the high speed stream from coronal hole 06 with density mainly below average. Total interplanetary magnetic field strength has been weak, with the north south component varying weakly, despite a persistent period of weakly negative Bz. Phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) has been at high levels throughout, peaking at 4250 pfu at 27/1710 UTC. The associated 24 hour fluence was Active (above 1e8 integrated pfu) with a rising trend, reaching 2.68e8 integrated pfu at 28/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be mainly Low to Moderate, with the main risk of flare activity from AR3315 and increasingly from AR3314. There is a slight chance of X-class flaring.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 25 May could glance the Earth on 29 May. A further feature which left the Sun on 26 May could glance Earth on 30 or 31 May. The current high speed stream is expected to wane towards background on 28 May with the fast wind from coronal hole 07 then connecting either on 28 or 29 May. Geomagnetic activity is expected to be mainly Quiet, but with a risk of Active or G1/Minor Storms on both 29 and 30 or 31 May due to potential CME impacts.

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Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. There is a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur, mainly from AR3314 or AR3315. High energy electron flux (greater than 2MeV) is expected to be at mostly high levels during the period. The forecast CME arrivals and high speed stream connections could generate enough geomagnetic activity reduce electron counts, but with limited confidence. Electron fluence values are expected to remain above the Active (1e8 integrated pfu) threshold, but with decreasing confidence later in the period due to the uncertainty of modifying factors.

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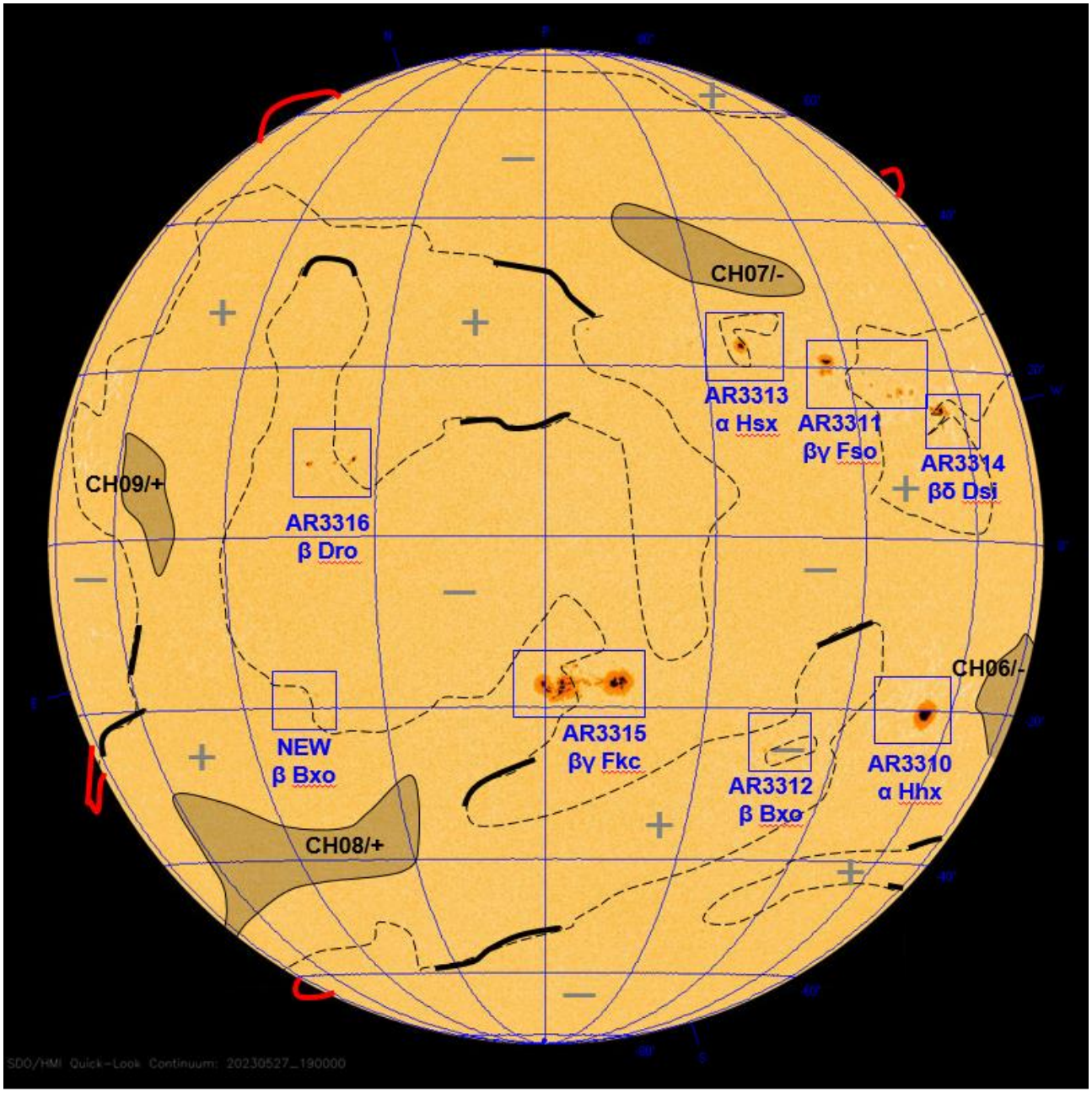
Figure 1. Solar Analysis Valid 27/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two Earth-directed CMEs in the forecast. An eruption which left the Sun on 25 May may glance the Earth on 29 May with a further possible glancing blow on 30 or 31 May from an eruption on 26 May, although much of this second feature is directed southward.
The high speed stream from coronal hole 06 is expected to continue to wane on 28 May. Based on persistence, the high speed stream from coronal hole 07 is likely to connect during 28 May, following a pattern on the previous rotation with the equivalent sized coronal holes. Coronal hole 07 is of a similar shape to the last rotation, lending additional credit to this aspect of the forecast. Speeds of 500km/s are expected, again using persistence as a guide.

Mainly Quiet geomagnetic activity is forecast throughout, with isolated Unsettled intervals. There is a slight chance of Active or G1/Minor Storms on 29 May and 30 or 31 May due to the low confidence CME arrivals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
26/0144	Partial	AR3312	S	347 km/s	29/2200 +/- 9 hours	Low confidence
27/0525	Partial	Unknown	38S 09E	310	30 or 31 May	Low confidence, glancing blow.

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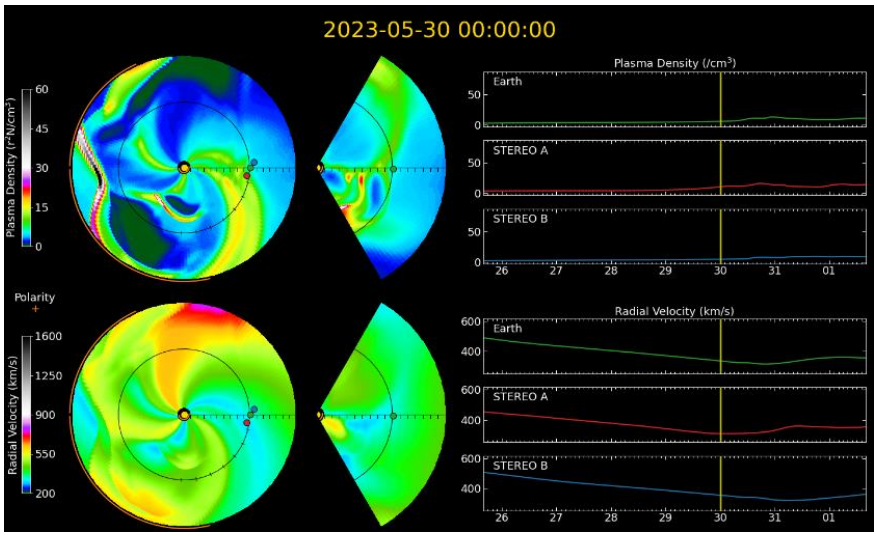
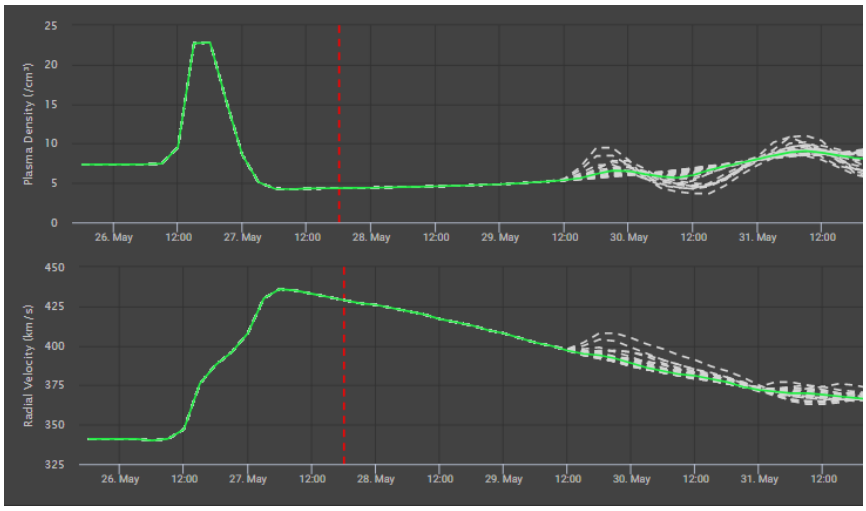
Figure 2: MOSWOC Enli and Enlil Ensemble forecast, showing the potential arrival of two weak CMEs on 29 and 30 or 31 May.





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Radio Blackouts - X-Ray Flares:
AR3315 has weakened slightly, with the central delta spot fading. In contrast AR3314 in the northwest has strengthened as a delta spot has developed in an otherwise small region. AR3311 continues to weaken, but has lengthened. Two weak regions on the eastern hemisphere are starting to emerge and will need to be monitored. The remaining regions are all either benign or stable.

Several regions, some of which may have been responsible for significant activity as they moved across the farside, are due to rotate onto the eastern limb over the next few days and could lead to a significant increase in solar activity.

Moderate to Low activity is forecast, with a slight chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES 16 X-ray flux

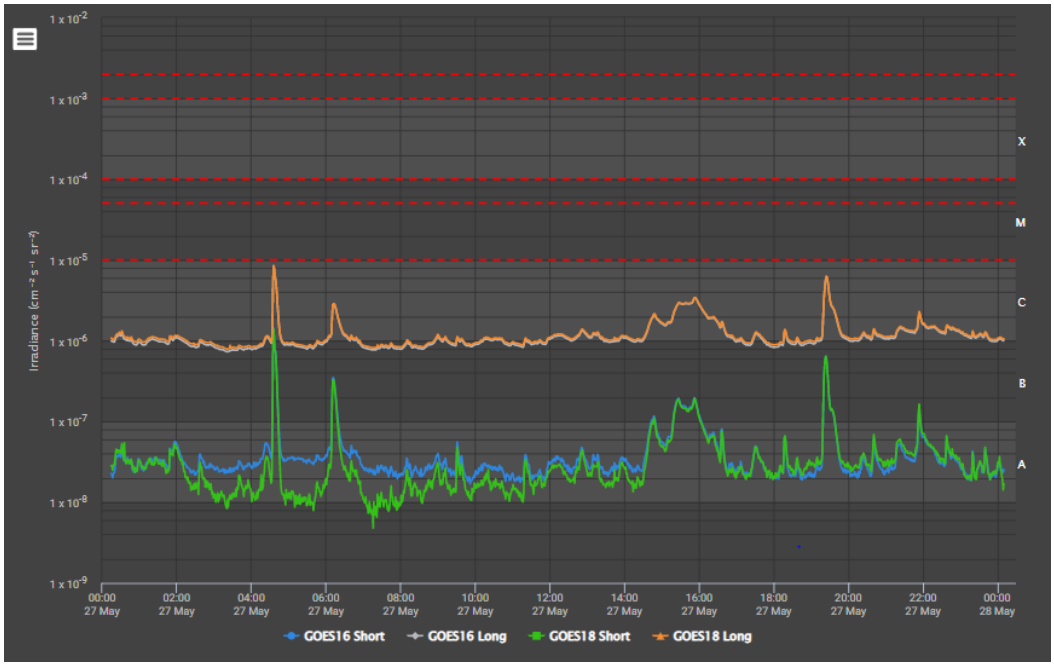

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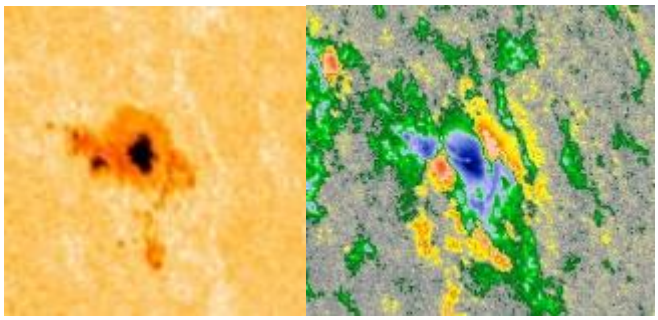
Figure 4: AR3314 in the northwest, exhibiting a delta structure.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and is currently expected to remain so throughout the period. There is a slight chance of an increase to the S1/Minor Storm level, should any larger flares occur, mainly from AR3315 or increasingly from AR3314.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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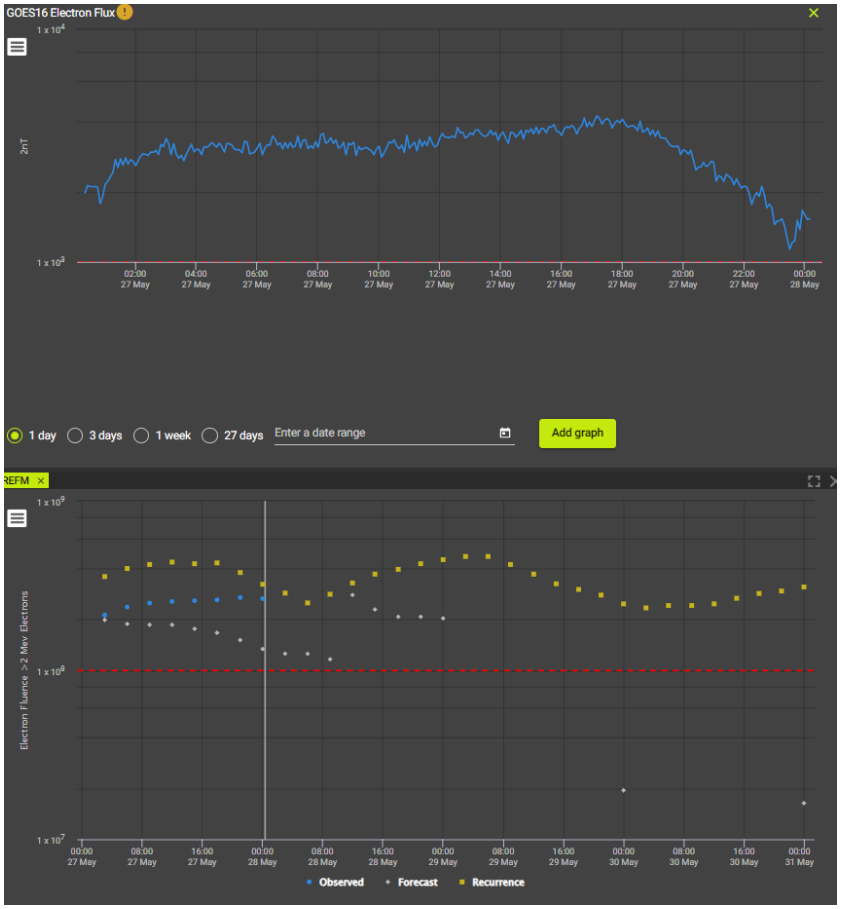
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at high levels and is expected to continue at similar levels in the absence of any high confidence modifying factors. However the most likely source of any geomagnetic activity is from two CMEs on 29 and 31 May, although both these are most likely to glance the Earth, resulting in limited geomagnetic activity. Associated 24 hour fluence is expected to remain above the Active (1e8 integrated pfu) throughout. The decrease in probabilities later in the period is due to uncertainties around the low confidence CME arrivals.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	80	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES 16 electron flux and MOSWOC REFM model. The forecast for the electron fluence is below that expected, with Active fluence expected through the next four days.



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